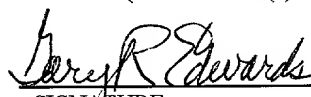| FORM PTO-1390 (REV 5-93) **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**	U.S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER **3036/49863**
		U.S. APPLICATION NO. (if known, see 37 CFR 1 5) **09/830466**

INTERNATIONAL APPLICATION NO. PCT/GB99/03546	INTERNATIONAL FILING DATE **26 October 1999 (27.10.99)**	PRIORITY DATE CLAIMED **27 October 1998 (27.10.98)**

TITLE OF INVENTION: **METHOD FOR IMPROVED EXTRACTION IN CDMA SYSTEMS**

APPLICANT(S) FOR DO/EO/US: **Anthony Peter HULBERT**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371

3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2)).

    a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).

    b. [X] has been transmitted by the International Bureau **(Form PCT/IB/308 attached)**

    c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)

6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))

    a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).

    b. [ ] have been transmitted by the International Bureau.

    c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.

    d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **(UNEXECUTED - 2 pages)**

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern other document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [ ] A FIRST preliminary amendment.

    [ ] A SECOND or SUBSEQUENT preliminary amendment.

14. [ ] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information: **2 sheets of drawings (Figures 1 and 2); International Preliminary Examination Report and amended sheets; 1st page of published International Application**

U.S. APPLICATION NO. (if known, see 37 CFR 1 5	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/830466	PCT/GB99/03546	**3036/49863**

17. [ ] The following fees are submitted:

	CALCULATIONS	PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EPO or JPO	$860.00	$860.00
International preliminary examination fee paid to USPTO (37 CFR 1.482)	$690.00	
No international preliminary examination fee paid to USPTO (37 CFR 1.482)		
but international search fee paid to USPTO (37 CFR 1.445(a)(2)	$710.00	
Neither international preliminary examination fee (37 CFR 1.482) nor		
international search fee (37CFR 1.445(a)(2) paid to USPTO	$ 1000.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482)		
and all claims satisfied provisions of PCT Article 33(2)-(4)	$100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =	$860.00	

Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)). $130.00

Claims	Number Filed	Number Extra	Rate		
Total Claims	16- 20 =		X $18.00	$	
Independent Claims	2- 3 =		X $80.00	$	
Multiple dependent claims(s) (if applicable)			+ $270.00	$	
		TOTAL OF ABOVE CALCULATIONS =		$130.00	

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28). $

SUBTOTAL =	$990.00	

Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).   + $

TOTAL NATIONAL FEE =	$990.00	

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). $40.00 per property + $

TOTAL FEE ENCLOSED =	$990.00	

	Amount to be:	$
	refunded	
	charged	$

a. [X] A check in the amount of $ **990.00** for the filing fee is enclosed

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment to Deposit Account No. __05-1323__ . **(Attorney Docket No. 3036/49863.)**A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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IMPROVEMENTS IN OR RELATING TO SIGNAL EXTRACTION

The present invention relates to improvements in or relating to signal extraction, and is more particularly concerned with extracting a desired signal

5   from a plurality of signals interfering with the desired signal.

The universal mobile telecommunication system (UMTS) terrestrial radio access (UTRA) uses code division multiple access (CDMA) as its multiple access technique. On the uplink (mobile terminal to base station direction), non-orthogonal codes are used in combination with power control.

10   However, because the codes are not orthogonal, the capacity of the uplink is limited by multiple access interference. The UTRA specification provides for the optional use of short codes to allow the use of various receiver techniques in the base station which rely on the fact that the multiple access interference is not noise but is, in fact, other signals. The receiver techniques which

15   operate in this way are generically known as interference cancellation and joint detection.

One implementation of interference cancellation operates by first demodulating the data on all of the signals directed to the base station to form estimates of the data. Knowledge of these estimates of the data along with

20   channel estimates allows the generation of delayed approximate replicas of the received signal from each of the mobile terminals. For each wanted signal, the replicas for the other signals are summed together and subtracted from a delayed version of the received composite signal. Thus, at this stage, the interference has been approximately cancelled for that signal. When

25   demodulation (including despreading) is performed, the bit error rate (BER) should be reduced. The whole process can be repeated several times, each time using the improved estimates of the received data to construct the approximate replicas.

One implementation of joint detection operates by treating the sum of the signals as a composite signal having travelled over a path with components relating to the individual signal components. This path is then linearly or non-linearly equalised in order to permit demodulation of all of the data over all of the signals.

In both interference cancellation and joint detection techniques, it is necessary to have knowledge of the bit rates (and, therefore, the spreading factors) for each of the received signals. In UTRA frequency division duplex (FDD), the signal format consists of frames of 10ms duration. There are two channels for each signal, namely, the dedicated physical control channel (DPCCH) and the dedicated physical data channel (DPDCH).

The DPCCH is a low power constant bit rate channel. It consists of 16 timeslots each comprising pilot symbols, forward error correction (FEC) encoded transport format indicator (TFI) data and transmit power control (TPC) data. The DPDCH consists of time interleaved, FEC encoded data. It has a bit rate which may vary from one frame to the next, the bit rate of which is carried by the TFI data in the DPCCH of the same frame. On the uplink, in a single spreading code transmission, the DPDCH is first spread to become the inphase (I) channel and the DPCCH is spread to become the quadrature (Q) channel. Overall scrambling is then applied to the combined signal.

The TFI data is spread out across the frame and cannot be reliably decoded until the whole of the current frame has been received. Thus the bit rate information, for each of the signals, is unavailable until the whole of the current frame has been received. This causes two problems:-

First, the reason for applying interference cancellation or joint detection is to increase the system capacity by allowing the reception of signals at a lower signal to noise plus interference ratio than would be

possible without using it. This means that before the applicant of

interference cancellation, it may be impossible to demodulate the TFI bits,

leading to a deadlock situation. This is true even though the DPCCH and

DPDCH are transmitted on nominally orthogonal (I and Q) channels since

5   multipath will seriously degrade this orthogonality and because the different

signals will be received at the base station with arbitrary mutual carrier phase.

Secondly, power control information is generated by making signal to

noise plus interference measurements on the DPCCH within the time period

of the frame. Thus, if interference cancellation or joint detection cannot be

10   applied until the end of the frame, these measurements will need to be based

on the signal to noise plus interference (SNI) without the benefit of

interference cancellation or joint detection. If the power control

measurement threshold is based on an adequate SNI ratio at this stage, then

the resultant SNI ratio after the operation of interference cancellation or joint

15   detection will be higher than necessary. On the other hand, attempting to

base the power control measurements on there being an adequate SNI ratio

after the operation of interference cancellation or joint is problematic

because: a) the SNI ratio at the measurement stage will be very low --

probably too low to measure, and b) it is not possible to predict, a priori, how

20   effective the interference cancellation or joint detection will be in any given

slot.

US-A-5151919 (Ericsson) provides a subtractive CDMA demodulation

system which optimally decodes a coded system embedded in many other

overlapping signals making up a received composite signal. A radio receiver

25   correlated a unique code corresponding o the desired signal to be decoded

with the composite signal. WO96/24206 (Nokia) provides a CDMA system

in which several users communicate simultaneously on the same frequency

band, and in which each user has its own spreading code. For reception of

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signals, signal correlators use synchronisation with waveforms of different types to aid decoding.

It is therefore an object of the present invention to provide an improved method of extracting a signal which overcomes the problems mentioned above.

In accordance with one aspect of the present invention, there is provided, in a communication system employing coded signals, a method of extracting a desired coded signal from a composite signal comprising the desired signal and one or more interfering coded signals, the method comprising the steps of:-

a)   receiving a composite signal;

b)   processing, for each received signal code, individual signals in a first signal processor;

c)   determining transport format indicator (TFI) signals using buffer and decoder circuits to provide a bit rate of a frame for at least one interfering signal;

d)   dividing the TFI signal path into first and second signal paths;

e)   wherein, in a first signal path TFI signals are passed via a latch to provide the first signal processor with a TFI signal, whereby to assign the bit rate determined for said last frame for the next frame; and

f)   wherein, in the second path TFI signals are passed to a further signal processor to adjust the bit rate of an output signal.

In accordance with a further aspect of the present invention there is provided, in a communication system employing coded signals, apparatus operable to extract a desired coded signal from a composite signal comprising the desired signal and one or more interfering coded signals, the apparatus comprising:-

a)   receiver means arranged to receive a signal;

AMENDED SHEET

b) a first signal processor for processing individual signals, for each received signal code;

c)   buffer and decoder circuits for determining transport format indicator (TFI) signals, to provide a bit rate of a frame for at least one interfering

5 signal;

d)   a path divider for dividing the TFI signal path into first and second signal paths;

wherein, in the first signal path, TFI signals are passed via a latch, to provide the first signal processor with a TFI signal, whereby to assign the bit rate

10 determined for said last frame for the next frame; and

wherein, in the second path, TFI signals are passed to a further signal processor to adjust the bit rate of an output signal.

For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings in which:-

15   Figure 1 illustrates a block diagram of one embodiment of a part of a base station of a telecommunications system in accordance with the present invention; and

Figure 2 illustrates a block diagram of another embodiment of a part of a base station in accordance with the present invention.

20   In accordance with the present invention, a first iteration of interference cancellation or joint detection is performed on incoming signals on the basis that the bit rates for every signal are the same as they were for the same signal in the previous frame. Although this assumption may not be true for all of the signals, it should be true for the vast majority of signals

25   whenever a large number of signals are present. If the frame rate is correct, for example, for 90% of signals, then nominally 90% of the interference would be cancelable. The unsuccessful attempt to cancel the remaining 10% of interference would add a further 10%, leaving the interference at 20% in

the ideal case. This provides a 7dB reduction in interference – a very useful start.

It will be appreciated that if the number of active signals is small then the operation of interference cancellation or joint detection will not be needed anyway.

As discussed above, in order to demodulate a CDMA signal

5 effectively, the bit rate of that signal needs to be determined. However, due to the interference produced by the presence of other co-channel signals, it is necessary to cancel that interference from the signal before the bit rate can be determined. As discussed above, there are two main methods of eliminating the effects of that interference, namely, interference cancellation and joint

10 detection. The present invention is described below with respect to both these techniques with reference to Figures 1 and 2 respectively.

Referring initially to Figure 1, a part of a base station is shown which comprises a receiving (R_x) antenna 100, a transmitting (T_x) antenna 300, and processing circuitry for down-converting received signals and up-converting

15 signals for transmission. Antenna 100 receives a plurality of radio signals from a plurality of mobile terminals (not shown) in a telecommunications cell which includes the base station. The received signals are passed from the antenna 100 to a mixer 102 where they are down-converted using the output from a local oscillator 104. As is the case with CDMA, each radio signal has

20 a unique code so that it can be distinguished from other radio signals received at the same time. The down-converted signals are passed to filter 106 and filtered output 108 is then passed to a bank 110 of Rake receivers. In the illustrated embodiment, four Rake receivers 112, 114, 116, 118 are shown, but it will readily be appreciated that any number of Rake receivers can be utilised

25 according to the receiving capacity of the base station. Each Rake receiver 112, 114, 116, 118 operates on a different code so that each received signal can be individually processed. In this example, Rake receiver 112

operates on code 1, Rake receiver 114 operates on code 2, Rake receiver 116 operates on code 3, and Rake receiver 118 operates on code 4.

Each Rake receiver 112, 114, 116, 118 receives all the plurality of filtered signals, but only demodulates and despreads the signal having the code associated with that receiver and outputs a decision variable signal in accordance with that demodulation and despreading. The decision variable signal from each Rake receiver 112, 114, 116, 118 is then fed to a respective one of decision devices 122, 124, 126, 128 which may be limiting devices. The limited outputs are then fed to respective remodulation/respreading units 132, 134, 136, 138 where the signals are remodulated and respread prior to being fed to respective channel reconstruct filters 142, 144, 146, 148.

Each Rake receiver 112, 114, 116, 118 also outputs a channel estimation signal CE – only the channel estimation signal CE1 from Rake receiver 112 being shown. Each channel estimation signal CE is input to a respective one of the channel reconstruct filters 142, 144, 146, 148 to enable reconstruction of each demodulated and despread signal. It is to be noted that, although only channel estimation signal CE1 is shown for clarity, it will be appreciated that Rake receivers 114, 116, 118 produce respective channel estimation signal CE2, CE3, CE4 (not shown) which are fed to corresponding reconstruct filters 144, 146, 148.

After the signals have been reconstructed, they are summed in summer 150 to form signal 155 which is an estimation of a delayed version of the filtered signal 108 input to the bank 110 of Rake receivers as described above. Signal 155 is then fed to a bank of subtractors 162, 164, 166, 168. It will be appreciated that a subtractor is provided for each signal which is to be extracted, and more subtractors will be required if more than four signals are to be extracted as described in the illustrated embodiment. Also fed to subtractors 162, 164, 166, 168, are respective signals 172, 174, 176, 178

which are tapped off the signals entering summer 150, each signal corresponding to the individual reconstructed signals. Subtractors 162, 164, 166, 168 subtract signals 172, 174, 176, 178 from signal 155 to provide output signals 182, 184, 186, 188 representing the 'interference' produced by the

5   presence of the other signals. For example, output signal 182 corresponds to the incoming signal 108 (same as signal 155 as discussed above) minus the signal 172, that is, the signal having code 1. Similarly, output signal 184 corresponds to signal 108 minus signal 174 (code 2), output signal 186 corresponds to signal 108 minus signal 176 (code 3), and output signal 188

10   corresponds to signal 108 minus signal 178 (code 4).

For clarity, the subsequent processing of signal 182 is described, but it will readily be appreciated that signals 184, 186, 188 are processed in a similar way.

Signal 182 is then passed to a further subtractor 190 where signal 182

15   is subtracted from a delayed version of signal 108. As shown, signal 108 is fed to a delay circuit 196 to provide delayed signal 198. The delay introduced by the delay circuit 196 is equivalent to the time for signal 108 to be processed by the bank of Rake receivers 110, decision devices 122, 124, 126, 128, remodulation/respreading units 132, 134, 136, 138, channel reconstruct filters

20   142, 144, 146, 148, summer 150, and subtractors 162, 164, 166, 168. Subtractor 190 produces an output signal 192 which represents the signal having code 1. Similarly, output signals 184, 186, 188 are also passed to subtractors (not shown for clarity) where they are subtracted from delayed signal 198 to provide output signals representing signals having codes 2, 3,

25   and 4.

Each output signal corresponding to each of the codes 2, 3, and 4 are also passed to respective further Rake receivers (not shown) and processed in

identical fashion to provide the output signals described with reference to code 1 below.

Output signal 192 is then passed to a further Rake receiver 202 where it is demodulated and despread to produce output signals 212, 222, 232, 242.

5   Output signal 212 corresponds to a tentative DPDCH signal which is passed to a DPDCH buffer 252. The tentative DPDCH signal comprises soft decision variables obtained on the basis of despreading according to the lowest currently available spreading factor. The output from buffer 252 is passed to circuit 262 where the bit rate is adjusted and the DPDCH decoded to provide

10   an output data signal 280. However, circuit 262 cannot adjust the bit rate and provide the output data signal 280 without knowing the bit rate. Output signal 222 comprises a TFI signal which is passed to a TFI buffer 254. Output from buffer 254 is passed to circuit 264 where the TFI signal is decoded and the bit rate is determined. Output signal 274 from circuit 264 is passed to circuit 262

15   to adjust the bit rate and to enable the data signal 280 to be output. Output signal 274 is also passed to a latch 290 which is connected to Rake receiver 112 for inputting the bit rate determined from the last frame. This bit rate is then used as an estimate for the next frame.

Signal 232 comprises a TPC signal which is used to control the power

20   which the mobile terminal needs to be transmitted to it by the base station.

Signal 242 comprises a SNI signal which is used to provide a measure of the signal to noise plus interference ratio being experienced for the particular signal being received on code 1. Signal 242 is compared with a threshold value in a comparator 272 to generate a series of downlink TPC bits

25   indicating to the relevant terminal whether its power should be reduced or increased. The output from the comparator 272 is modulated in modulator 284, mixed with other data in multiplexer 286, spread in spreader 288, up-

converted in mixer 292 fed by local oscillator 294, and amplified by amplifier 296 before being transmitted by antenna 300.

The other data input to multiplexer 286 will include similarly processed SNI signals from the other further Rake receivers (not shown)

5   corresponding to codes 2, 3 and 4.

Referring now to Figure 2, an arrangement utilising joint detection for removal of unwanted signals is shown. Components which have been previously described with reference to Figure 1 are referenced the same.

In Figure 2, a part of a base station is shown which comprises a

10   receiving (R_x) antenna 100, a transmitting (T_x) antenna 300, and processing circuitry for down-converting received signals and up-converting signals for transmission. Antenna 100 receives a plurality of radio signals from a plurality of mobile terminals (not shown) in a telecommunications cell which includes the base station. For ease of explanation, the processing of the received

15   signals is described with reference to four signals each having a unique code, for example, code 1, code 2, code 3, and code 4 as above. The received signals are passed from the antenna 100 to a mixer 102 where they are down-converted using the output from a local oscillator 104. As is the case with CDMA, each radio signal has a unique code so that it can be distinguished

20   from other radio signals received at the same time. The down-converted signals are passed to filter 106 and filtered output 108 is then passed to a joint detection device 400. Device 400 processes the filtered output 108 to generate a TFI signal, a TPC signal and an SNI signal for each code – only code 1 and 4 are shown for simplicity, but it will readily be appreciated that

25   codes 2 and 3 are identical.

For code 1, device 400 is shown as producing a TFI signal 402 , a TPC signal 404 and a SNI signal 406. Similarly, for code 4, TFI signal 412, TPC signal 414 and SNI signal 416 are shown. TFI signals 402, 412 are

passed to respective circuits 420, 430 where they are buffered and decoded. Output signals 422, 432 from circuits 420, 430 are passed to a second joint detection device 500. Signals 422, 432 are also passed to respective frame latch devices 440, 450, outputs 442, 452 therefrom being used to input bit rate

5   information for joint detection device 400 for the next frame of respective signals having code 1 and code 4.

      TPC signals 404, 414 are used to provide information for controlling the power which the mobile terminal needs to be transmitted to it by the base station. SNI signals 406, 416 are used to provide an indication to the mobile

10   terminal of the interference being experienced.

      For clarity, subsequent processing is only shown for signal 406. Signal 406 is compared with a threshold value in a comparator 272 and if the signal 406 is above the threshold, an output signal is provided which passes through switch 282, modulated in modulator 284, mixed with other data in multiplexer

15   286, spread in spreader 288, up-converted in mixer 292 fed by local oscillator 294, and amplified by amplifier 296 before being transmitted by antenna 300.

      The other data input to multiplexer 286 will include similarly processed SNI signals from the other further Rake receivers (not shown) corresponding to codes 2, 3 and 4.

20   Filtered input signals 108 are also fed to a delay circuit 196. The delay of circuit 196 is chosen to compensate for delays introduced during joint detection in device 400 and buffering and decoding in circuits 420, 430. The delayed signal 198 provides the input to joint detection device 500 as shown. As discussed above, signals 422, 432 are used to provide bit rate

25   information which is used to provide DPDCH signals 510, 520, 530, 540 from device 500.

In a further embodiment of the present invention (not illustrated), the first bank 110 of Rake receivers 112, 114, 116, 118 may be replaced with a joint detection device 400 to determine the bit rate so that the signals can be decoded in the further Rake receivers as described above.

1.   In a communication system employing coded signals, a method of extracting a desired coded signal from a composite signal comprising the desired signal and one or more interfering coded signals, the method comprising the steps of:-

a)   receiving a composite signal;

b)   processing, for each received signal code, individual signals in a first signal processor (112 – 118; 400);

c)   determining transport format indicator (TFI) signals using buffer and decoder circuits (254, 264; 420, 430) to provide a bit rate of a frame for at least one interfering signal;

d)   dividing the TFI signal path into first and second signal paths;

e)   wherein, in a first signal path (442, 452), TFI signals are passed via a latch (290; 440, 450) to provide the first signal processor with a TFI signal, whereby to assign the bit rate determined for said last frame for the next frame; and

f)   wherein, in the second path (422, 432), TFI signals are passed to a further signal processor (262; 500) to adjust the bit rate of an output signal (280; 510 – 540).

2.   A method according to Claim 1 wherein the first signal processor comprises a bank of Rake receiver (112-118), each Rake receiver (112-118) demodulating and despreading only signals having a code associated with the Rake receiver, each Rake receiver (112-118) outputting a decision variable signal which is applied to a decision device (122-128) which limits the output and, the decision device (122-128) outputting to a remodulation/respread unit (132-138) which provides a remodulated and respread signal to a channel reconstruction filter (142-148), the

filter (142-148) receiving a channel estimation signal (CE1) from said Rake receiver (112-118) to provide a reconstructed signal.

3.   A method according to Claim 2 wherein the reconstructed signal is fed to a summer (150) to provide a signal (155) which is then subtracted in a bank of subtractors (162-168) which subtracts a signal (172-178) corresponding to the individual reconstructed signal (182-188).

4.   A method according to Claim 3 wherein the signal corresponding to the individual reconstructed signal (182-188) is processed by a further Rake receiver (202) to provide;

i. a demodulated and despread signal to dedicated physical data channel (DPDCH) buffer (252); and

ii. a transport format indicator (TFI) signal (222);

wherein the TFI signal is buffered in TFI buffer (254), the bit rate is determined and passed to the bit rate adjuster circuit (264).

5.   A method according to Claim 2 wherein the further Rake receiver (202) provides a transmit power control (TPC) signal whereby to enable a transmitter to transmit signals to the receiver at an appropriate power level.

6. A method according to Claim 2 wherein the further Rake receiver (202) provides a signal to noise plus a deference (SNI) signal (242).

7.   A method according to Claim 1 wherein the first signal processor comprises a first joint detection device (400), the joint detection device processing signals with respect to their signal codes whereby to determine TFI signals.

8.   A method according to claim 7, wherein the first signal processor provides a plurality of further control signals for extracting said desired signal.

9.   A method according to claim 8, wherein said plurality of further control signals comprise a transmit power control (TPC) signal and a signal to noise plus interference (SNI) signal.

10.   In a communication system employing coded signals, apparatus operable to extract a desired coded signal from a composite signal comprising the desired signal and one or more interfering coded signals, the apparatus comprising:-

a)   receiver means arranged to receive a signal;

b)   a first signal processor (112 – 118; 400) for processing individual signals, for each received signal code;

c)   buffer and decoder circuits (254, 264; 420, 430) for determining transport format indicator (TFI) signals, to provide a bit rate of a frame for at least one interfering signal;

d)   a path divider for dividing the TFI signal path into first and second signal paths;

wherein, in the first signal path (442, 452), TFI signals are passed via a latch (290; 440, 450), to provide the first signal processor with a TFI signal, whereby to assign the bit rate determined for said last frame for the next frame; and

wherein, in the second path (422, 432), TFI signals are passed to a further signal processor (262; 500) to adjust the bit rate of an output signal (280; 510 – 540).

11.   Apparatus according to Claim 10 wherein the first signal processor comprises a bank of Rake receiver (112-118), each Rake receiver (112-118)

operable to demodulate and despread only signals having a code associated with the Rake receiver, each Rake receiver (112-118) being operable to output a decision variable signal which is applied to a decision device (122-128) which is operable to limit the output and, the decision device (122-128) being operable to output to a remodulation/respread unit (132-138) which is operable to provide a remodulated and respread signal to a channel reconstruction filter (142-148), the filter (142-148) being operable to receive a channel estimation signal (CE1) from said Rake receiver (112-118) to provide a reconstructed signal which is fed to a summer (150) to provide a signal (155) which is then subtracted in a bank of subtractors (162-168) which are operable to subtract a signal (172-178) corresponding to the individual reconstructed signal (182-188).

12. Apparatus according to Claim 11 comprising a further Rake receiver (202) and a TFI buffer (254), wherein the further Rake receiver is operable to process the signal from the subtractor (190) to provide:

    i. a demodulated and despread signal to dedicated physical data channel (DPDCH) buffer (252); and

      ii. a transport format indicator (TFI) signal (222);

    wherein the TFI signal is buffered in the TFI buffer, and the bit rate is determined and passed to the bit rate adjuster circuit (264).

13. Apparatus method according to Claim 12 wherein the further Rake receiver (202) is operable to provide a transmit power control (TPC) signal whereby to enable a transmitter to transmit signals to the receiver at an appropriate power level.

14. A method according to Claim 12 wherein the further Rake receiver (202) is operable to provide a signal to noise plus a deference (SNI) signal (242).

15. A method according to Claim 10 wherein the first signal processor comprises a first joint detection device (400), the joint detection device being operable to process signals with respect to their signal codes whereby to determine TFI signals.

16. A method according to claim 15, wherein the first signal processor is operable to provide a plurality of further control signals for extracting said desired signal.
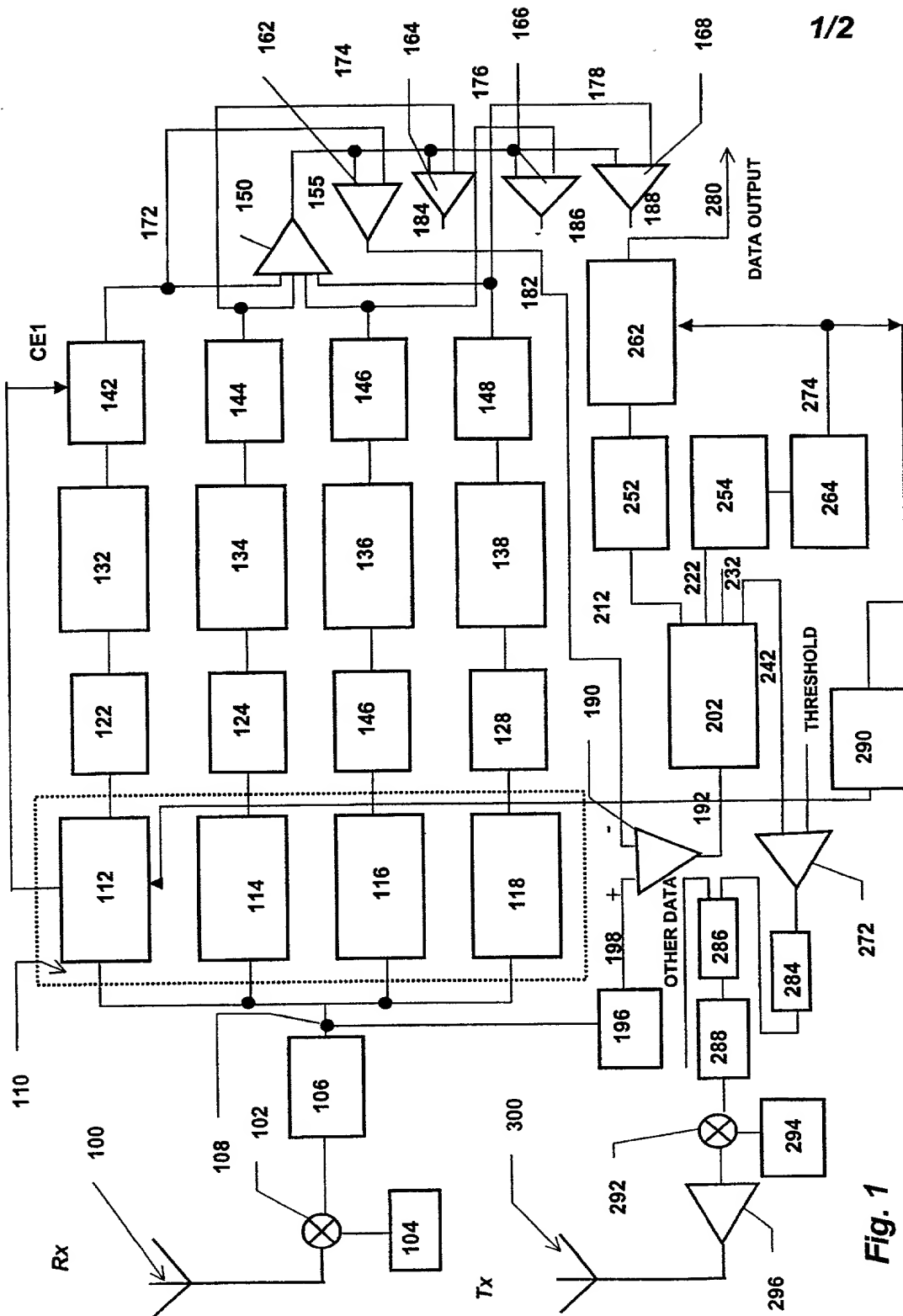
16. A method according to claim 15, wherein said plurality of further control signals comprise a transmit power control (TPC) signal and a signal to noise plus interference (SNI) signal.

ABSTRACT

IMPROVEMENTS IN OR RELATING TO SIGNAL EXTRACTION

Described herein is a method for improving signal extraction in a code division multiple access (CDMA) telecommunications system. The method comprises performing a first iteration of interference cancellation on the basis of bit rates for every signal which are the same as they were in a previous frame of the same signal. Filtered and down-converted signals 108 are demodulated in Rake receivers (112, 114, 116, 118) to provide output signals corresponding to decision variables and channel estimates. The decision variables are limited and remodulated and respread prior to the signals being reconstructed using the channel estimates. The reconstructed signals are summed and each signal (172, 174, 176, 178) is subtracted from the sum (155) to provide an 'interference' signal (182, 184, 186, 188) which is then used to obtain the individual signals. Each signal is then demodulated a second time in another Rake receiver (202) to provide a tentative DPDCH signal (212), a TFI signal (222), a TPC signal (232) and a SNI signal (242). The TFI signal (222) is processed to provide a signal (274) indicative of the bit rate which is used to both decode the DPDCH signal (222) providing a data output (280) and to provide an estimate of the bit rate for a subsequent frame of the same signal.

(Fig. 1)

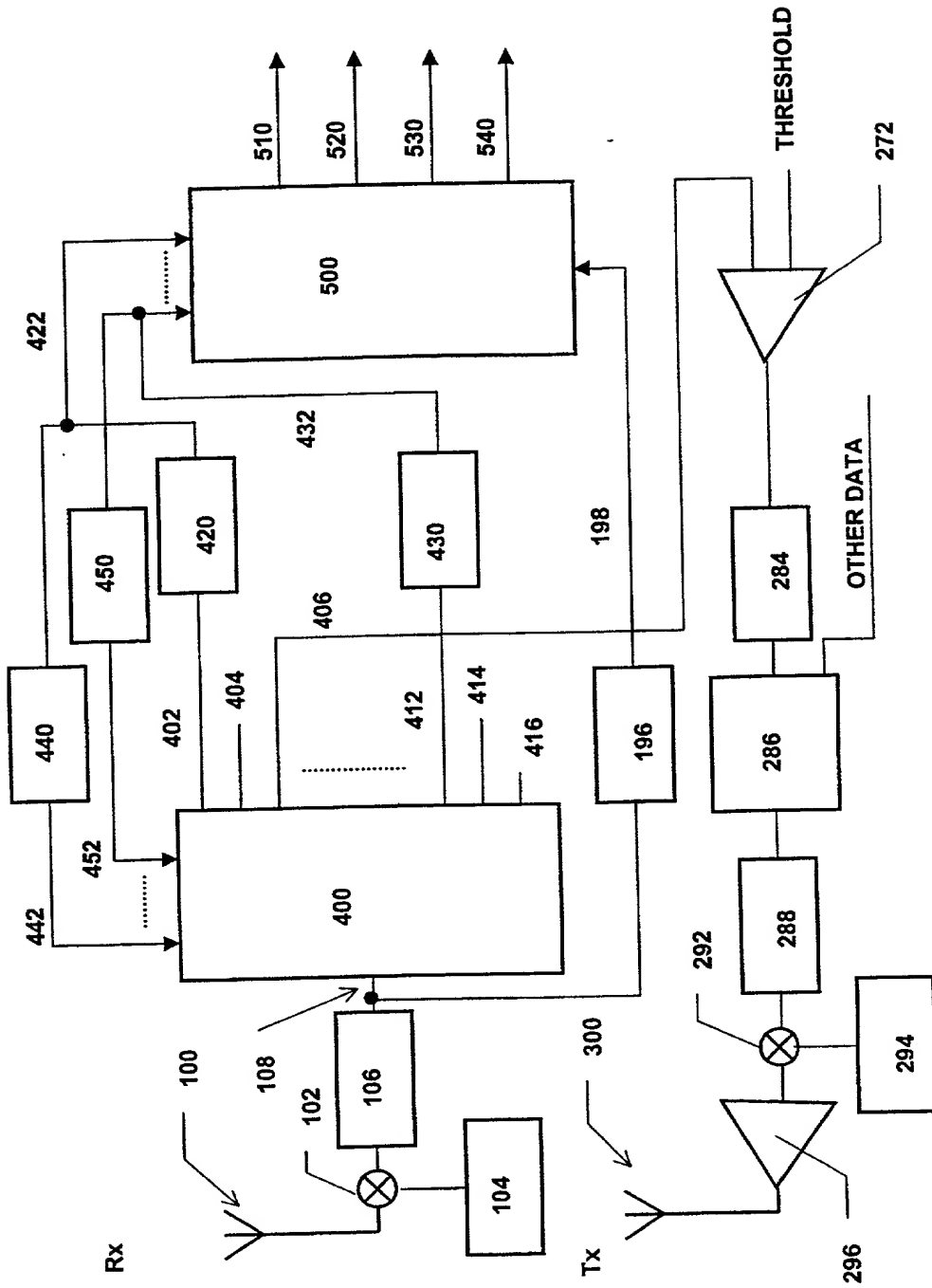Fig. 1

Fig. 2

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)	ATTORNEY'S DOCKET NUMBER 3036/49863

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD FOR IMPROVED EXTRACTION IN CDMA SYSTEMS

the specification of which (check only one item below):

[ ] is attached hereto.

[ ] was filed as United States application
     Serial No. _____
     on _____
     and was amended
     on _____ (if applicable).

[X] was filed as PCT international application
     Number PCT/GB99/03546
     on _____26 October 1999 (26.10.99)_____
     and was amended under PCT Article 19
     on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. §1.56(a).

I hereby claim foreign priority benefits under Title 35, United State Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Great Britain	9823439.6	27 October 1998 (27.10 98)	[X] Yes [ ] No
Great Britain	9913872.9	16 June 1999 (16.06.99)	[X] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

Combined Declaration For Patent Application and Power of Attorney (Continued) (includes Reference to PCT international Applications	ATTORNEY'S DOCKET NUMBER 3036/49863

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national of PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120

U.S. APPLICATIONS		STATUS (Check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (IF ANY)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
Anthony Peter Hulbert		
DATE 1st May 2001	Date	DATE

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